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Contributions to the Mesozoic flora of the Atlantic coastal plain—  
VIII. Texas\*

EDWARD W. BERRY

(WITH PLATES 30-32)

The following annotated list of fossil plants is based on a small collection from the Woodbine formation, made at Arthurs Bluff on the Red River in Lamar County, Texas, by Doctors T. W. Stanton and L. W. Stephenson in 1911 for the U. S. Geological Survey.

The presence of fossil plants in the Cretaceous strata of Lamar County has been known for half a century as is shown by a letter from Dr. B. F. Shumard, dated Oct. 2, 1860, read before the Academy of Science of St. Louis at its session of Nov. 5, 1860, and quoted on page 140 of the printed Transactions.† Dr. B. F. Shumard, at that time state geologist of Texas, states that his brother Dr. G. G. Shumard discovered numerous dicotyledonous leaves resembling the modern leaves of *Salix*, *Ilex*, *Laurus*, etc., in the Cretaceous yellowish sandstones of Lamar County near the Red River. These were undoubtedly from the locality now known as Arthurs Bluff, which has furnished the subsequent collections. Dr. Shumard further states that these plants were sent to Leo Lesquereux for determination, but if sent they were apparently lost in transit.‡

When R. T. Hill took up the study of the Texas Cretaceous, new collections were made between 1880 and 1885 at Arthurs Bluff and at Denison, the latter a locality originally discovered by Dr. Shumard. These collections were, according to Hill, sent to the U. S. National Museum and lost in storage. Finally in Hill's great work on the Texas Cretaceous§ Dr. F. H. Knowlton furnished a report on collections of fossil plants from the Woodbine formation

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\* Published with the permission of the Director of the U. S. Geological Survey.

† Trans. Acad. Sci. St. Louis 2: 140. 1868.

‡ Lesquereux, Cretaceous Flora, U. S. Geol. Surv. Terr. 6: 11. 1874.

§ Hill, Geography and Geology of the Black and Grand Prairies, Ann. Rep. U. S. Geol. Surv. 21<sup>7</sup>: 314-318. pl. 39. 1901.

at Arthurs Bluff, Lamar County; Woodbine, Cooke County; and Denison, Grayson County.

The largest of these collections is the one from Arthurs Bluff, which was made in 1894 by Dr. T. Wayland Vaughan. The plants are preserved in a fragmentary state in a yellowish sandy clay or loose sandstone. Dr. Knowlton identified the following species from this locality:

<i>Aralia Wellingtoniana Vaughanii</i> Knowlton	<i>Phyllites rhomboideus</i> Lesq.
<i>Benzoïn venustum</i> (Lesq.) Knowlton	<i>Platanus primaeva</i> Lesq.
<i>Diospyros primaeva</i> Heer	<i>Sapindus Morrisoni</i> Heer?
<i>Ficus glascoeana</i> Lesq.?	<i>Salix deleta</i> Lesq.
<i>Liriodendron pinnatifidum</i> Lesq.?	<i>Viburnum robustum</i> Lesq.
<i>Myrica longa</i> (Heer) Heer	

The collection from Woodbine in Cooke County was made by G. H. Ragsdale and is reported as containing:

<i>Andromeda Pfaffiana</i> Heer	<i>Diospyros primaeva</i> Heer
<i>Cinnamomum ellipsoideum</i> Sap. & Mar.	<i>Eugenia primaeva</i> Lesq.
<i>Cinnamomum</i> sp.?	<i>Phyllites aristolochiaeformis</i> Lesq.?

The collection from Denison, Grayson County, was made by T. V. Munson from two outcrops in that town, Munson Hill, from which Dr. Knowlton is unable to identify any forms specifically, and Rhamey Hill, from which the following are recorded:

<i>Cinnamomum Heerii</i> Lesq.	<i>Magnolia Boulayana</i> Lesq.
<i>Diospyros Steenstrupi</i> Heer	<i>Magnolia speciosa</i> Heer
<i>Inga cretacea</i> Lesq.	<i>Populus</i> sp.?
<i>Laurus proteaefolia</i> Lesq.	<i>Salix</i> sp.?
<i>Liquidambar integrifolium</i> Lesq.	

Confining any comments to the collection studied by the writer we may note that out of a total of 27 species, three species and one variety of which are new, seventeen are forms either described or recorded from the Dakota group. It is greatly to be regretted that no very precise stratigraphic significance can be attached to any particular units of the Dakota group flora, since the Dakota group materials have been recognized over a very wide area in a more or less unscientific way and no careful stratigraphic-paleobotanic work has ever been carried out.

Since the Woodbine formation of northeastern Texas undoubtedly represents deposits laid down during a part of Dakota group time, they should naturally contain this large Dakota group element. If we judge by the range of the Woodbine species

that occur in the Cretaceous of the Atlantic coastal plain as shown in the appended table, the Woodbine represents an earlier rather than a later part of the Dakota interval. Eleven Woodbine species are found in the lower Raritan, eleven in the upper Raritan, eleven in the Magothy, and fifteen in the lower Tuscaloosa of western Alabama. From extensive studies of this large lower Tuscaloosa flora it seems probable that its basal portion represents the time equivalent of the uppermost Raritan, and there are sixteen species from these two horizons represented in the Woodbine collection. The small representation in the upper Tuscaloosa is without chronologic significance, since it merely reflects our present lack of knowledge of the constituents of this upper Tuscaloosa flora. The presence of only five of these species in the Black Creek-Middendorf beds of the Carolinas, while it probably indicates that the latter are in the main younger than the Woodbine,\* would be more impressive if all five were not extremely abundant and wide-ranging forms, all being present in either the lower Raritan or the lower Tuscaloosa. Only two species are found in the lower Eutaw, the older character of the Woodbine flora being particularly emphasized by the absence of the characteristic gymnosperms, such as *Araucaria bladenensis* Berry, *Araucaria Jeffreyi* Berry, *Sequoia*, *Cunninghamites*, *Tumion*, the two species of *Androvettia*, etc. In fact, the Woodbine flora is remarkable by reason of the almost total absence of gymnosperms, only two forms, *Brachyphyllum macrocarpum formosum* and *Podozamites lanceolatus*, being represented in the present collection, and none being recorded in the previous collections studied by Knowlton.

Our knowledge of the Woodbine flora is much too limited for any positive conclusions regarding the botanical or physical conditions that attended its development; and larger collections are much to be desired, since the small collections studied by the writer and by Dr. Knowlton indicate the presence in these beds of a large and varied, even if fragmentarily preserved, flora. This, when collected and studied, may be expected to show the relation between the Dakota flora and that from the Cheyenne sandstone of

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\* I regard the Middendorf as the equivalent of a part of the Tuscaloosa and the typical Black Creek as representing the upper Tuscaloosa and lower Eutaw.

southern Kansas, so that eventually we will know what are the older and what the younger elements in the Dakota flora.

Seven species in the Arthurs Bluff collection extend northward along the Atlantic coastal plain to western Greenland, and four additional species in the lists of Woodbine plants quoted from Knowlton's report have a like distribution. These are sufficient to indicate that climatic conditions at this time in the Upper Cretaceous were much more uniform than they are at the present time. A consideration of the large collections from the Tuscaloosa formation of Alabama shows that the latter, when compared with the contemporaneous Greenland flora, while essentially similar, contains additional elements that may legitimately be regarded as tropical or subtropical. It seems evident that while the differences in climate between Greenland and Texas were infinitely less in Woodbine time than they are today, there was a distinct

	Dakota group	Lower Tuscaloosa	Upper Tuscaloosa	Lower Raritan	Upper Raritan	Magothy	Black Creek- Middendorf	Lower Eutaw
<i>Andromeda Novae-caesareae</i> Hollick.....	×	×	.....	.....	×	×	×	×
<i>Andromeda Snowii</i> Lesq.....	×	.....	.....	.....	.....	.....	.....	.....
<i>Aralia Wellingtoniana</i> Lesq.....	×	.....	.....	×	.....	.....	.....	.....
<i>Benzoin venustum</i> (Lesq.) Kn.?	×	.....	.....	.....	.....	.....	.....	.....
<i>Brachyphyllum macrocarpum formosum</i> var. nov.....	.....	×	.....	.....	.....	×	×	×
<i>Cinnamomum membranaceum</i> (Lesq.) Hol- lick.....	×	.....	.....	.....	.....	×	.....	.....
<i>Colutea primordialis</i> Heer.....	.....	.....	.....	×	×	.....	.....	.....
<i>Cornophyllum vetustum</i> Newb.....	.....	×	.....	×	.....	.....	.....	.....
<i>Eucalyptus Geinitzi</i> (Heer) Heer.....	×	×	×	×	×	×	×	.....
<i>Ficus daphnogenoides</i> (Heer) Berry.....	×	×	.....	×	×	×	×	.....
<i>Laurophyllum minus</i> Newb.....	.....	.....	.....	.....	×	.....	.....	.....
<i>Laurus plutonia</i> Heer.....	×	×	.....	×	×	×	×	.....
<i>Liriodendron quercifolium</i> Newb.....	.....	.....	.....	×	.....	.....	.....	.....
<i>Magnolia speciosa</i> Heer.....	×	×	.....	×	.....	×	.....	.....
<i>Malapoenna falcifolia</i> (Lesq.) Kn.?	×	×	.....	.....	.....	×	.....	.....
<i>Myrica emarginata</i> Heer.....	×	×	.....	×	×	.....	.....	.....
<i>Oreodaphne alabamensis</i> sp. nov.....	.....	×	.....	.....	.....	.....	.....	.....
<i>Palaeocassia laurinea</i> Lesq.....	×	×	.....	.....	.....	.....	.....	.....
<i>Podzamites lanceolatus</i> (L. & H.) Braun..	×	.....	.....	×	×	×	.....	.....
<i>Populus harkeriana</i> Lesq.....	×	.....	.....	.....	×	.....	.....	.....
<i>Rhamnus tenax</i> Lesq.....	×	×	.....	.....	.....	.....	.....	.....
<i>Rhus redditiformis</i> sp. nov.....	.....	.....	.....	.....	.....	.....	.....	.....
<i>Sapindus Morrisoni</i> Lesq.....	×	×	.....	.....	×	×	.....	.....
<i>Sterculia lugubris</i> Lesq.?	×	.....	.....	.....	.....	.....	.....	.....
<i>Tricalycites papyraceus</i> Newb.....	.....	×	.....	×	×	?	.....	.....
<i>Viburnum robustum</i> Lesq.?	×	.....	.....	.....	.....	.....	.....	.....
<i>Zizyphus lamarensis</i> sp. nov.....	.....	×	.....	.....	.....	.....	.....	.....

increase in mean annual temperatures in proceeding southward from the latitude of Greenland.

Conditions comparable to those of Woodbine time occur in those areas where the tropical flora extends many degrees farther than its normal range to the north or south of the equator, becoming more or less mixed with temperate elements to form the flora typical of temperate rain forests like that of New Zealand, so often cited. The extension of the Upper Cretaceous flora southward across the present torrid zone indicates less torrid conditions during the Cretaceous than in the present day tropical belt, so that it will be extremely difficult, even if it ever becomes possible, to discriminate between subtropical and warm temperate Cretaceous climates, and to assert with any confidence that the imaginary line separating the two shall be placed in the South Atlantic or Middle Atlantic states or still farther to the northward.

The appended table shows the range in the United States of the species discussed in the following notes:

#### GYMNOSPERMAE

##### PODOZAMITES LANCEOLATUS (L. & H.) F. Braun

*Zamia lanceolata* Lind. & Hutton, Foss. Fl. 3: 121. pl. 194. 1836.

*Podozamites lanceolatus* F. Braun, in Münster, Beitr. Petref. 2<sup>6</sup>: 33. 1843.

This form, described originally from the English Oolite, has a very wide recorded geological and geographical range. A large number of Jurassic varieties have been described, and indistinguishable forms occur in both the Lower and Upper Cretaceous of both America and Europe. In the Upper Cretaceous it occurs in the Raritan formation from Long Island to Maryland and in the Cenomanian of Bohemia, as well as in the Dakota group of Kansas.

While it is almost inconceivable that these similar detached leaflets from such various horizons represent a single botanical species, no criteria other than the unsafe one of stratigraphic position are available for their discrimination. The Arthurs Bluff collection contains a single perfect and typical leaflet, and whether it is specifically identical with all of the other forms referred to this species or not, it is of great interest in showing the presence of a gymnosperm of this type in the Woodbine flora.

***Brachyphyllum macrocarpum formosum* var. nov.**

*Brachyphyllum macrocarpum* Berry, Bull. Torrey Club 37: 183. 1910; 38: 420. 1911. (Not Newberry, 1896.)

DESCRIPTION: Slender elongated twigs, pinnately branched, covered with medium-sized, crowded, appressed leaves, spirally arranged. Leaves bluntly pointed, relatively smooth, thick. (PLATE 30.)

In the consideration of the various specimens that have been referred to *Brachyphyllum macrocarpum* Newberry, a very considerable variation within certain fixed limits is at once obvious. This variation is usually one of size, the more slender specimens being at the same time more elongated and smoother. This has been frequently noted by the writer and is commented upon in print by Dr. F. H. Knowlton,\* who in discussing the later forms (from Wyoming) suggests that the species on the verge of extinction became smaller in its proportions.

In studying the material from the South Atlantic and Gulf States a constant difference in size was noticed by the writer. This may reflect a slight difference in climatic conditions, and all of the forms may be interpreted as the variations of a single species, in fact, one of Newberry's figures† of a Raritan specimen is approximately the same size as the forms from the Montana group of the West and is associated with the normal, stout, club-shaped type. That the variety has no particular stratigraphic significance is indicated by its abundance at a horizon as old as the basal Tuscaloosa formation in Alabama and its presence in the Woodbine formation. In general, however, it occurs at later and more southern horizons than the type. This might be ascribed to the fact that only the slender and more elongated terminal twigs are preserved at these localities; but such an explanation is regarded as improbable, since the same reasoning should hold good for the areas where only the thicker twigs have been found.

The remains are usually much macerated and broken, and this is eminently true of the three specimens from Arthurs Bluff. The warrant for describing them as a new variety is furnished by the

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\* Knowlton, Bull. U. S. Geol. Surv. 163. 29. *pl.* 4. *f.* 5, 6. 1900.

† Newberry, Mon. U. S. Geol. Surv. 26: 51. *pl.* 7. *f.* 1-7. 1896 (see *f.* 7).

discovery of a large and rather complete specimen in the Magothy formation of Maryland. The latter shows the terminal part of two approximately parallel and curved twigs, about 12 cm. in length, united proximad. These in their thickest portion are only 6 mm. in diameter. At intervals of from 3 mm. to 5 mm., subopposite lateral branches are given off in a pinnate manner. These are relatively much elongated, curved, and slender, averaging about 4 cm. in length by 2 mm. in diameter, bluntly pointed and not tapering to any appreciable extent. These have been infrequently observed to fork pseudo-dichotomously, and at times they give off toward their distal ends tiny lateral branchlets less than a centimeter in length and about one millimeter in diameter. The general proportions are thus decidedly different from the parent type. The leaves are slightly smaller and smoother and somewhat more elongated in their relative proportions, at the same time lacking the apical papillae and the convergent striae. The new variety is much more graceful than the type in appearance, and in its general aspect suggests the Lower Cretaceous genus *Arthrotaxopsis*. The most closely allied form appears to be one from the Albian of Portugal, described by Saporta\* as *Brachyphyllum obesiforme elongatum*. There is also considerable resemblance to *Brachyphyllum crassicaule* Fontaine of the Patapsco formation in Maryland and Virginia. Remains of this new variety are associated with the type in Maryland; they are abundant throughout the Tuscaloosa of Alabama, ranging upward into the basal part of the Eutaw formation in both Alabama and western Georgia.

## MYRICALES (?)

## MYRICA EMARGINATA Heer

*Myrica emarginata* Heer, Fl. Foss. Arct. 6<sup>2</sup>: 66. *pl. 4. f. 2.* 1882.  
—Lesquereux, Mon. U. S. Geol. Surv. 17: 67. *pl. 12. f. 1.* 1892.—Newberry, Mon. U. S. Geol. Surv. 26: 62. *pl. 41. f. 10, 11.* 1896.—Berry, Bull. N. J. Geol. Surv. 3: 104. *pl. 10. f. 5.* 1911.

Leaves obovate in outline, widest at the rounded-truncate and more or less emarginate apex. Margins entire, narrowing to the cuneate base. Midrib medium stout, inclined to be somewhat

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\* Saporta, Fl. Foss. Portugal 176. *pl. 31. f. 14.* 1894.



flexuous. Secondaries about five thin subopposite pairs, diverging from the midrib at angles of about 45 degrees, camptodrome.

A single but entirely typical leaf of this species is contained in the collection. It is identical with the remains of this species as they occur in the basal part of the Tuscaloosa formation in Alabama and in the Dakota sandstone of Kansas. It is relatively wider and more robust than the type material from the Atane beds of Greenland, being intermediate in character between the type material and that referred to this species from the Raritan formation of New Jersey. Its reference to the genus *Myrica* is entirely problematical.

#### SALICALES

##### POPULUS HARKERIANA Lesq.

*Populus harkeriana* Lesq. Fl. Dakota Group 44. *pl.* 46. *f.* 4. 1892.

—Hollick, Mon. U. S. Geol. Surv. 50: 49. *pl.* 7. *f.* 31. 1907.

This species was described by Lesquereux from the Dakota group at Fort Harker, Kansas, and was subsequently recorded by Hollick from the Cretaceous material (Raritan or Magothy) in the terminal moraine near Tottenville, Staten Island. The Arthurs Bluff collection contains a single specimen and its counterpart showing half of a large typical leaf of this species. There is also an undeterminable species of the *Populus* type in the collection.

#### URTICALES

##### FICUS DAPHNOGENOIDES (Heer) Berry

*Proteoides daphnogenoides* Heer, Phyll. Crét. Nebr. 17. *pl.* 4. *f.* 9, 10. 1866.

*Ficus daphnogenoides* Berry, Bull. Torrey Club 32: 327. *pl.* 21. 1905.

This species was described originally from the Dakota group of Nebraska by Heer. It is a widespread and common Upper Cretaceous form ranging from Marthas Vineyard to Alabama in the Atlantic coastal plain and from Northwest Territory to Kansas and Nebraska in the western interior. It is abundant in the lower part of the Tuscaloosa formation in western Alabama. The Arthurs Bluff collection contains three fragmentary specimens showing the characteristic attenuated tip of this species.

Figs are apparently much less abundant in the Woodbine than

in the Tuscaloosa formation on the eastern shore of the Cretaceous Mississippi embayment.

## RANALES

### MAGNOLIA SPECIOSA Heer

*Magnolia speciosa* Heer, Neue Denks. Schw. Gesell. **23**: 20. *pl.* 6. *f.* 1; *pl.* 9. *f.* 2; *pl.* 10. *f.* 1. 1869.—Knowlton, Ann. Rep. U. S. Geol. Surv. **21**<sup>7</sup>: 318. 1901.

A single small leaf of this species is contained in the collections from Arthurs Bluff. *Magnolia speciosa* was described by Heer from the Cenomanian of Moravia, and subsequently it has been found to have a wide range in North America, being recorded from the Dakota group and from the Raritan and Magothy formations along the Atlantic coast. In Alabama it is confined to the lower part of the Tuscaloosa formation, where it is abundant. It was reported by Knowlton (loc. cit.) in 1901 in a small collection from the Woodbine formation at Rhamey Hill, Denison, Texas, made by T. V. Munson of Denison.

### LIRIODENDRON QUERCIFOLIUM Newberry

*Liriodendron quercifolium* Newb. Bull. Torrey Club **14**: 6. *pl.* 62. *f.* 1. 1887; Fl. Amboy Clays 81. *pl.* 51. *f.* 1-6. 1896.—Berry, Bull. N. J. Geol. Surv. **3**: 138. *pl.* 17. *f.* 1. 1911.

This species was described a quarter of a century ago by Newberry from the middle Raritan of Woodbridge, N. J., to which locality it has been hitherto confined. It is a very characteristic leaf with a broadly emarginate summit and three or four pointed laterally directed lobes on each side, separated by relatively narrow sinuses. The venation is of the *Liriodendron* type with strong secondaries.

While the present determination is based upon a single incomplete specimen, it is undoubtedly a fragment of this species and is about as complete, as well as similar in outline and size, as Newberry's *fig.* 2. It shows the two upper lateral lobes of one side of a leaf, separated by a sharp, not deep sinus, separated from a larger but similar basal lateral lobe by a deeper and broader sinus, and is absolutely characteristic.

Knowlton (loc. cit.) has recorded *Liriodendron pinnatifidum* Lesq., doubtfully, and *Liriodendron Snowii* Lesq., positively, from

Arthurs Bluff, but neither of these species is represented in the present collection. Both are characteristic forms and so different that there is no possibility of confusing them with the species just discussed.

#### ROSALES

##### PALAEOCASSIA LAURINEA Lesq.

*Palaeocassia laurinea* Lesq. Fl. Dakota Group 147. *pl.* 64. *f.* 12. 1892.

This species was described from the Dakota group of Kansas, to which it has been hitherto confined. As interpreted by Lesquereux, its describer, the remains represented leaflets of a *Cassia*-like plant, although so far as I know, all have been found detached, the only basis for considering them leaflets rather than leaves being their slight inequilateral form.

A single entire leaf is contained in the collection from Arthurs Bluff. It is identical with the type material from Kansas in size, outline, and venation, with the exception that it is slightly wider (2-5 mm.) with a consequently somewhat fuller and more rounded base. It has recently been detected in the lower Tuscaloosa of Alabama.

##### COLUTEA PRIMORDIALIS Heer

*Colutea primordialis* Heer, Fl. Foss. Arct. 6<sup>2</sup>: 99. *pl.* 27. *f.* 7-11; *pl.* 43. *f.* 7, 8. 1882.

This well-marked little species was described from the Atane beds of Greenland. It occurs in strata at least as old as the upper Raritan in New Jersey and is present in both the Dakota and Magothy floras.

The collection from Arthurs Bluff contains a single complete and in every way typical leaf of this species.

#### SAPINDALES

##### SAPINDUS MORRISONI Lesquereux

*Sapindus Morrisoni* Lesq.; Heer, Fl. Foss. Arct. 6<sup>2</sup>: 96. *pl.* 40. *f.* 1; *pl.* 41. *f.* 3; *pl.* 43. *f.* 1a, b; *pl.* 44. *f.* 7, 8. 1882.—Knowlton, Ann. Rep. U. S. Geol. Surv. 21<sup>7</sup>: 317. 1901.

This species was described by Heer from the Atane beds of west Greenland and identified with the manuscript species of the same name which Lesquereux had given to a Dakota group

plant from Morrison, Colorado. It is a common Dakota group form occurring also in the Raritan, Tuscaloosa, and Magothy formations of the Atlantic coastal plain. Fragmentary specimens occur in the collection from Arthurs Bluff, where it was also recorded by Knowlton in 1901 (loc. cit.).

***Rhus redditiformis* sp. nov.**

DESCRIPTION: Leaves compound, probably trifoliate. Leaflets petiolate, ovate in outline, with bluntly pointed tips, cuneate bases, and entire or undulate margins forming occasional distal shallow broadly rounded lobules separated by broad shallow sinuses. Terminal leaflet nearly equilateral, about  $\frac{1}{3}$  larger than the lateral leaflets, about 4 cm. in length by 2 cm. in maximum width, which is about midway between the apex and the base; petiolule 5 mm. long; midrib stout, prominent; secondaries thin, 5 or 6 alternate pairs, branching from the midrib at angles of about  $50^\circ$ , curving slightly upward, anastomosing close to the entire margin. Lateral leaflets inequilateral, the outer limb of the lamina being slightly wider and fuller than the inner limb; petioles shorter than that of the terminal leaflet, 2-3 mm. in length, diverging from the latter at angles of about  $70^\circ$ ; in outline and venation similar to the terminal leaflet, but smaller and showing a tendency to develop slight irregularities in the margin, especially toward their tips. (PLATE 31, FIG. 2.)

This species is obviously new and is named from its rather striking resemblance to the European early Tertiary species *Rhus reddita* Saporta\* from Aix in southeastern France. Several Cretaceous species of *Rhus* have been described from horizons as old as the Woodbine, the Dakota group of Kansas furnishing three well-marked species with pinnate leaves, one of which *Rhus Uddeni* Lesquereux† is reported by Ward from the so-called Cheyenne sandstone at Belvidere, Kansas. A small toothed species has been described by Velenovsky‡ from the Cenomanian sandstone of Bohemia as *Rhus cretacea*, although this name was already in use for a very different Cretaceous species described by Heer§ from the Senonian of Quedlinburg in Saxony and recorded by Hollick|| from the Upper Cretaceous of Long Island. The Woodbine

\* Saporta, Etudes 1: 124. pl. 13. f. 2, a, b. 1862.

† Lesquereux, Mon. U. S. Geol. Surv. 17: 154. pl. 57. f. 2. 1892.

‡ Velenovsky, Fl. Böhm. Kreidef. 4: 7. pl. 4. f. 7-12. 1885.

§ Heer, Fl. Quedlinburg 14. pl. 3. f. 11. 1872.

|| Hollick, Mon. U. S. Geol. Surv. 50: 87. pl. 33. f. 2. 1907.

species is readily distinguishable from all of the foregoing and adds a well-marked and probably trifoliate Cretaceous form to this genus, which is so largely developed during Tertiary times. In the existing flora *Rhus* is a prominent element with upwards of 150 species, which are for the most part natives of warm temperate and tropical regions. A modern species with almost identical foliage is *Rhus villosa* L., a south African form.

OCCURRENCE: Woodbine formation, Arthurs Bluff, Red River, Lamar County, Texas.

COLLECTION: U. S. National Museum.

***Zizyphus lamarensis* sp. nov.**

DESCRIPTION: Leaves elliptical in outline, 4.5 cm. to 5 cm. in length by 3 cm. in maximum width about midway between the apex and the base, slightly nearer the latter; base full and rounded; lateral margins full and rounded; apex rounded, slightly less full than the base; margin with regular but shallow crenate teeth becoming less prominent toward the base. Midrib slender but prominent, straight. Lateral primaries one on each side, diverging from the midrib at its extreme base at an acute angle (about  $10^{\circ}$ ), thin, slightly curved inward above their middle, joining a secondary in the apical part of the leaf. Secondaries from the midrib two or three alternate thin pairs in the apical region, camptodrome; secondaries from the lateral primaries five or six in number, on the outside, curved, camptodrome; the lowest secondary is longest and branches at the most acute angle (about  $10^{\circ}$ ) and from the extreme base, each successively higher secondary subtending a slightly larger angle and following a somewhat shorter course. Internal tertiaries more or less percurrent, marginal ones similar to the secondaries from the primaries in their arrangement and course, thin and camptodrome. (PLATE 31, FIG. 1.)

This handsome species of an undoubted *Zizyphus* is unfortunately represented by very scant material. It is entirely distinct from any described Cretaceous species and is much closer to various Tertiary and still existing forms. It has recently been detected in the lower Tuscaloosa of Alabama.

**RHAMNALES**

**RHAMNUS TENAX Lesquereux**

*Rhamnus tenax* Lesq. Am. Jour. Sci. 46: 101. 1868; Fl. Dakota Group 170. pl. 38. f. 6. 1892.

This species was described many years ago by Lesquereux from the Dakota sandstone of southern Kansas and subsequently reported by Bartsch from the same horizon in Iowa. It is abundant in the lower Tuscaloosa of western Alabama, and a single characteristic specimen is contained in the Arthurs Bluff collection.

## MALVALES

## STERCULIA LUGUBRIS Lesquereux?

*Sterculia lugubris* Lesq. Cret. and Tert. Fl. 81. *pl.* 6. *f.* 1-3. 1883.

This species is apparently represented at Arthurs Bluff by the single specimen figured, which agrees very well with the Dakota group forms of *Sterculia lugubris*. It is queried since it may represent a slender almost parallel-margined form of *Aralia Wellingtoniana Vaughanii* Knowlton, which is so common at this locality. (PLATE 31, FIG. 3.)

## THYMELEALES

## BENZOID VENUSTUM (Lesq.) Knowlton

*Lindera venusta* Lesq. Fl. Dakota Group 95. *pl.* 16. *f.* 1, 2. 1892.

*Benzoid venustum* (Lesq.) Knowlton, Bull. U. S. Geol. Surv. 152: 47. 1898; Ann. Rep. U. S. Geol. Surv. 21: 317. *pl.* 39. *f.* 2. 1901.

This is a trilobate Dakota group species, described originally from Kansas and identified by Knowlton in 1901, in a collection made at Arthurs Bluff by T. W. Vaughan.

The present collection contains two fragmentary specimens which I have little hesitancy in referring to this species, especially as it has already been reported from this locality.

## MALAPOENNA FALCIFOLIA (Lesq.) Knowlton?

*Litsea falcifolia* Lesq. Fl. Dakota Group 97. *pl.* 11. *f.* 5. 1892.

*Malapoenna falcifolia* (Lesq.) Knowlton, Bull. U. S. Geol. Surv. 182: 142. 1898.

This species was described from the Dakota group of Kansas by Lesquereux and recorded by the writer from the Magothy formation in New Jersey. The Arthurs Bluff collection contains a single specimen of the lower half of a leaf which is doubtfully identified as this species. It is clearly distinguishable from

*Malapoenna horrellensis* Berry,\* of the Black Creek formation in North Carolina, by its suprabasilar primaries and cuneate base but may possibly be a fragment of *Cinnamomum Newberryi* Berry.†

***Oreodaphne alabamensis* sp. nov.**

DESCRIPTION: Leaves of large size, ovate in general outline, ranging from 13 cm. to 20 cm. in length, and from 4.75 cm. to 7 cm. in maximum width, which is at a point about midway between the apex and the base. From the point of greatest width the margins curve, both distad and proximad, in a very full curve, narrowing rather abruptly to the acuminate tip and also to the more or less decurrent base. Midrib stout, curved. Lateral primaries opposite, one on each side, branching from the midrib at an acute angle a considerable distance above its base, rather straight in their course, thinner than the midrib. Above the primaries there is an interval, and then about six pairs of thin, curved, approximately parallel, camptodrome secondaries branch from the midrib at acute angles. The lateral primaries give off on the outside numerous regularly spaced and approximately parallel curved camptodrome secondaries, the latter feature serving to distinguish this species from other fossil species of this genus, and from *Cinnamomum*, *Cocculus*, or other genera with somewhat similar leaves with which it might be compared. Texture coriaceous. (PLATE 32.)

This fine large species is represented at Arthurs Bluff by fragmentary but characteristic specimens. The foregoing description and the figure are drawn from abundant and complete material collected by the writer from the lower Tuscaloosa of western Alabama. It shows considerable variation in size and some in outline, the latter dependent on whether the leaf is widest nearer to or farther from the base. In the latter case the distal part is more fully rounded and abruptly contracted to the acuminate tip, while the base is more gradually narrowed and finally cuneate rather than decurrent. In the former case the apical portion is more gradually narrowed and the base is full and rounded abruptly, decurring to the petiole.

This species is markedly different from previously described fossil forms but may be matched by several modern tropical American species of *Oreodaphne*. The genus *Oreodaphne* of Nees,

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\* Berry, Bull. Torrey Club 37: 198. pl. 24, f. 1-9. 1910.

† Berry, loc. cit. 38: 423. 1911.

which is exclusively American in the existing flora, is made a subgenus of *Ocotea* Aublet by Pax in Engler and Prantl's *Die Natürlichen Pflanzenfamilien*. The latter genus, which for paleobotanical purposes may be considered as composite, has about two hundred modern species, occurring chiefly in the American tropics and ranging from southern Florida to Brazil and Peru, but with some representation (subgenus *Mespilodaphne* Nees) in the Canary Islands, South Africa, Madagascar, and the Mascarene Islands.

The single existing American species reaching the United States, whose habit and environment may be taken as typical for the whole genus, is found in Florida, southward from capes Canaveral and Romano along the shores and islands with the exception of some of the western keys, making its best growth in the rich, moist, hammock lands near the coast.

#### CINNAMOMUM MEMBRANACEUM (Lesq.) Hollick

*Paliurus membranaceus* Lesq. *Am. Jour. Sci.* **46**: 101. 1868.

*Cinnamomum membranaceum* Hollick, *Mon. U. S. Geol. Surv.* **50**: 75. *pl.* 29. *f.* 5, 6. 1907.

Two leaves of this species, identical with Hollick's *fig. 6*, except that one is slightly smaller, were found at Arthurs Bluff. The previous occurrences are the Dakota group and Glen Cove, Long Island (Raritan or Magothy formations).

#### LAURUS PLUTONIA Heer

*Laurus plutonia* Heer, *Fl. Foss. Arct.* **6**<sup>2</sup>: 75. *pl.* 19. *f.* 1*d*, 2-4; *pl.* 20. *f.* 3*a*, 4-5; *pl.* 28. *f.* 10, 11; *pl.* 42. *f.* 4*b*. 1882.

This species was described by Heer from the Atane beds of west Greenland and a large number of somewhat variable and fragmentary specimens were figured. Subsequently it was recorded from a very large number of Cretaceous plant beds, so that its range, both geographical and geological, is rather extensive. A number of these records are not entirely above suspicion, and this appears to be especially true of the forms from the Cenomanian of Bohemia identified by Velenovsky.

*Laurus plutonia* is rare in the Raritan, the writer having found it only near the top of that formation. It is abundant in the



overlying Magothy formation from New Jersey to Maryland. In the southern coastal plain it occurs in the Middendorf beds of South Carolina and ranged from the base of the Tuscaloosa formation upward into the Eutaw formation in the Alabama area.

A single complete and characteristic leaf and several fragments are contained in the Arthurs Bluff collections.

#### LAUROPHYLLUM MINUS Newberry

*Laurophyllum minus* Newb. Fl. Amboy Clays 86. *pl.* 16. *f.* 7-9. 1896.

This species was described from the Raritan formation of New Jersey and found by the writer in the upper part of that formation only. In the absence of venation characters in both the type and later collected material its identification is always more or less uncertain; and it may represent a variety of *Laurus plutonia* Heer or some of the forms that have been referred to *Myrica longa* Heer, although in general it is wider than the latter and more elongated and less symmetrical than the former. A single specimen is present in the collection from Arthurs Bluff.

#### MYRTALES

##### EUCALYPTUS GEINITZI (Heer) Heer

*Eucalyptus Geinitzi* Heer, Fl. Foss. Arct. 6<sup>2</sup>: 93. *pl.* 19. *f.* 1c; *pl.* 4. *f.* 1, 13. 1885.

This widespread and characteristic Upper Cretaceous species is found from the base of the Raritan formation of New Jersey upward into the Black Creek and Middendorf beds of the Carolinas. The type locality is the Cenomanian of Moravia, but it has also been recorded from the Atane beds of west Greenland and from the Dakota group of the West. In the Alabama Cretaceous it has been collected from only the lower part of the Tuscaloosa formation.

A single characteristic leaf is present in the collections from Arthurs Bluff.

#### UMBELLALES

##### ARALIA WELLINGTONIANA Lesq. emend.

*Aralia Wellingtoniana* Lesq. Fl. Dakota Group 131. (in part) *pl.* 21. *f.* 1. 1892 (not *pl.* 22. *f.* 2, 3, which are referred to *Aralia*

*Saportana*).—Newberry, Fl. Amboy Clays 114. *pl.* 26. *f.* 1. 1896.—Berry, Bull. N. J. Geol. Surv. 3: 202. *pl.* 25. *f.* 7. 1911 (not Smith, Geol. Coastal Plain Ala. 348. 1894).

This handsome species is characterized by its describer as being palmately 3- to 5-lobed, but it certainly seems significant that all of the forms from the Raritan formation are invariably 3-lobed and that the 5-lobed forms from the Dakota sandstone which Lesquereux referred to this species are indistinguishable from his species *Aralia Saportana*, which occurs at the same horizon and, in part at least, at the same locality.

This is the most abundant form collected at Arthurs Bluff, there being fifteen specimens in the one small collection, several nearly complete leaves being present. These are all trilobate with toothed margins and agree exactly with the Raritan leaves of this species and with the trilobate leaves from the Dakota sandstone like the one figured by Lesquereux on *pl.* 21. *fig.* 1.

In the light of our present knowledge *Aralia Wellingtoniana* may be recharacterized in the following terms:

Leaves variable in size, 10–20 cm. in length by 8 to 15 cm. in maximum width from tip to tip of the lateral lobes, average size about 15 cm. in length by 11 cm. in width; coriaceous, palmately deeply trilobate, with a rapidly narrowed and more or less extended decurrent base; lobes long, lanceolate, widest in the middle and narrowing below, somewhat abruptly acuminate, the median slightly the longest, diverging at an angle of about 30°, separated by sinuses extending more than halfway to the base, narrowly rounded; margins entire below and for varying distances upward, passing gradually into dentate-serrate teeth, one to each secondary or sometimes less in number, prominent in some specimens where they are more or less extended and directed upward, separated by wide shallow sinuses. Primaries stout, suprabasilar, the median slightly larger than the laterals. Secondaries numerous, thin, regular, subparallel, ascending, since the angle of their divergence from the primaries averages about 33°, but slightly curved in their course, ultimately craspedodrome in distal parts of leaf, where the margin is toothed, and camptodrome in the basal half of the leaf, where the margin is entire. Areolation indistinct, reticulate, of quadrangular or polygonal meshes. The smaller leaves are relatively shorter and broader, with less extended lobes and more open and less deep sinuses.

The present species may be distinguished from *Aralia cotton-*

*dalensis* Berry of the Tuscaloosa formation, with which it was confused by Ward (in Smith, Geol. Coastal Plain Ala. 348. 1894), by the shorter more conical lobes of the latter, its broadly rounded base and more crenate marginal teeth.

*Aralia Saportana* as here restricted to the 5- or 6-lobed forms is very close to *Aralia Wellingtoniana* and may be regarded as an offshoot from it. The fact that the two are associated in the Dakota group only and not in New Jersey or Texas rather controverts regarding them as the variants of a single species; and suggests that at least geographic varieties are represented, particularly as the trilobate form is so abundant at Arthurs Bluff that it is hard to conceive of trees with 5-lobed leaves growing in the vicinity whose foliage failed to be preserved. Furthermore, as the writer correlates the deposits, both the New Jersey Raritan and the Texas Woodbine at Arthurs Bluff are older than the Dakota sandstone in that area in Kansas from which Lesquereux described the 5-lobed forms, so that there is every reason for regarding *Aralia Saportana* as the direct descendant of *Aralia Wellingtoniana*.

The present species is also very similar to *Aralia decurrens* Velenovksy\* from the Cenomanian of Bohemia, which, however, has relatively narrower and more elongated lobes, with coarser teeth and deeper sinuses.

In reporting on a collection made by Vaughan at Arthurs Bluff and now in the U. S. National Museum, Knowlton† mentions *Aralia Wellingtoniana Vaughanii* var. nov. as the most abundant form observed. This variety was distinguished from the type by its trilobate form, more slender lobes and entire margins. This variety is not contained in the present collection.

#### CORNOPHYLLUM VETUSTUM Newberry

*Cornophyllum vetustum* Newb. Fl. Amboy Clays 119. pl. 19. f. 10. 1896.—Berry, Bull. N. J. Geol. Surv. 3: 196. 1911.

This species has heretofore been known only in the lower and middle Raritan beds in the New Jersey area, although it is present in undescribed collections from the lower Tuscaloosa made by

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\* Velenovsky, Fl. Böhm. Kreidef. 3: 11. pl. 4. f. 5-7. 1884.

† Knowlton, in Hill, Ann. Rep. U. S. Geol. Surv. 21: 317. 1901.

the writer near Glen Allen, Ala. It is very similar to species of *Cornus* described from the Dakota group, the Atane beds of west Greenland, and the Magothy formation of Maryland. It is represented in the collection from Arthurs Bluff by one good specimen.

VIBURNUM ROBUSTUM Lesq.?

*Viburnum robustum* Lesq. Fl. Dakota Group 120. *pl.* 20. *f.* 4-6.  
1892.—Knowlton, Ann. Rep. U. S. Geol. Surv. 21<sup>7</sup>: 317. 1901.

Knowlton records a single nearly perfect leaf of this Dakota group species from Arthurs Bluff. The same species is represented by fragments in the present collection.

ERICALES (?)

ANDROMEDA NOVAE-CAESAREAE Hollick

*Andromeda Novae-caesareae* Hollick in Newb. Fl. Amboy Clays  
121. *pl.* 42. *f.* 9-12, 28-31. 1896.

This well marked species, which appears in the upper Raritan formation of New Jersey and is so abundant at somewhat later horizons in the coastal plain southward as far as Alabama, is represented by three complete leaves in the collections from Arthurs Bluff. These Texas leaves are of the type with a rounded apex so common in the Black Creek beds of North Carolina.

While the species is found in both the Black Creek beds of North Carolina and in the Middendorf beds of South Carolina, both horizons considerably younger than the Raritan, it appears to be confined to the basal part of the Tuscaloosa formation in western Alabama.

ANDROMEDA SNOWII Lesquereux

*Andromeda Snowii* Lesq. Fl. Dakota Group 117. *pl.* 17. *f.* 16.  
1892.

This Dakota group species, previously recorded from Kansas, is represented by a single specimen from Arthurs Bluff. It resembles the lanceolate leaves of the preceding species but is broader with less numerous and much less ascending secondaries.

INCERTAE SEDIS

TRICALYCITES PAPYRACEUS Hollick

*Tricalycites papyraceus* Hollick, Bull. Torrey Club 21: 63. *pl.* 180.  
*f.* 8. 1894.

This very characteristic tri-alate fossil is abundant in the middle and upper Raritan formation of New Jersey. It occurs sparingly in the overlying Magothy formation and is very common in the lower part of the Tuscaloosa formation in western Alabama. It is abundant at Arthurs Bluff, the present collection containing eight typical specimens, some of them complete. They are in exact agreement with the Tuscaloosa forms and demonstrate what is discussed at length in my manuscript of the Tuscaloosa flora that the approximately parallel longitudinal venation of the wings is really a more or less forked and anastomosing venation, thus allying these fossils in a remote way with such modern genera as *Valica* of the Dipterocarpaceae.

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#### Explanation of plates 30-32

##### PLATE 30

*Brachyphyllum macrocarpum formosum* Berry var. nov., Sullivans Cove, Maryland.

##### PLATE 31

FIG. 1. *Zizyphus lamarensis* Berry sp. nov., Arthurs Bluff, Texas.

FIG. 2. *Rhus redditiiformis* Berry sp. nov., Arthurs Bluff, Texas.

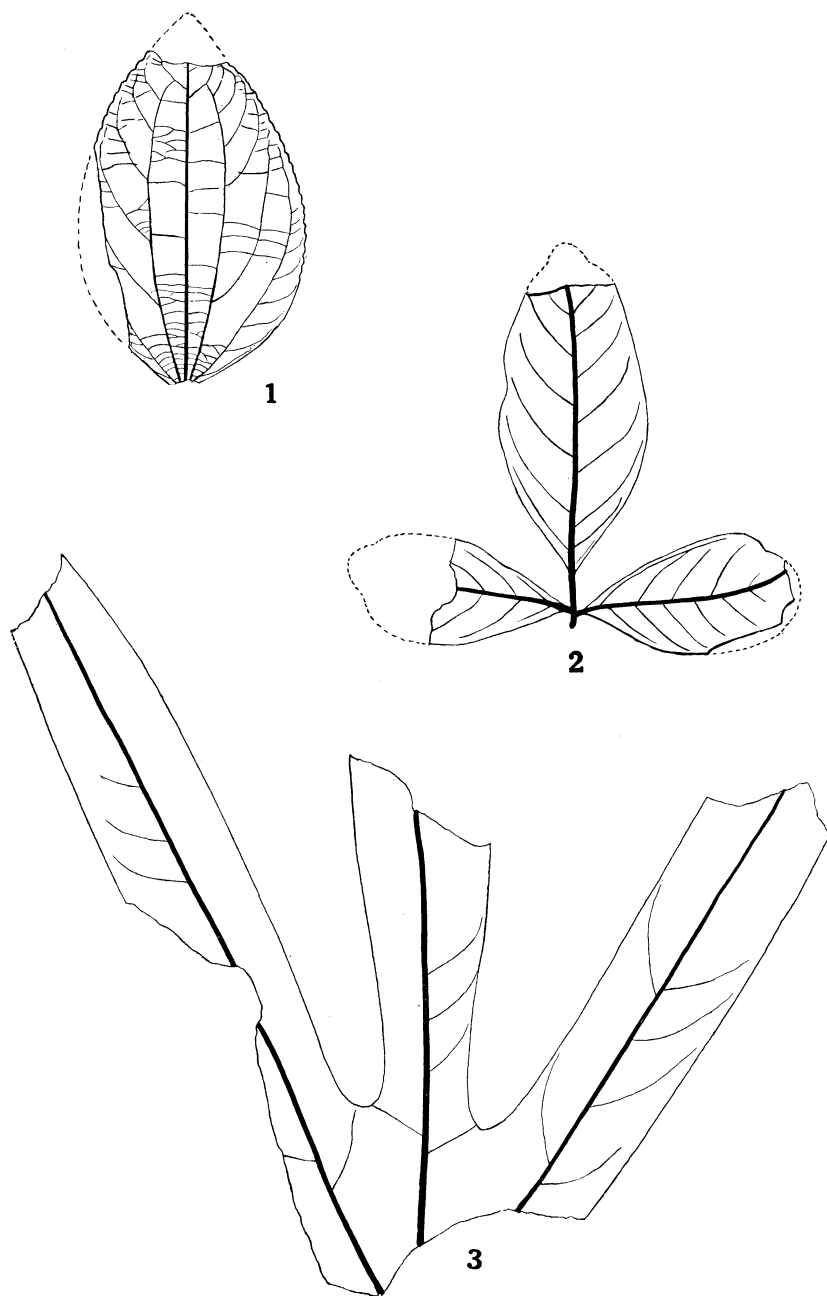
FIG. 3. *Sterculia lugubris* Lesquereux, Arthurs Bluff, Texas.

##### PLATE 32

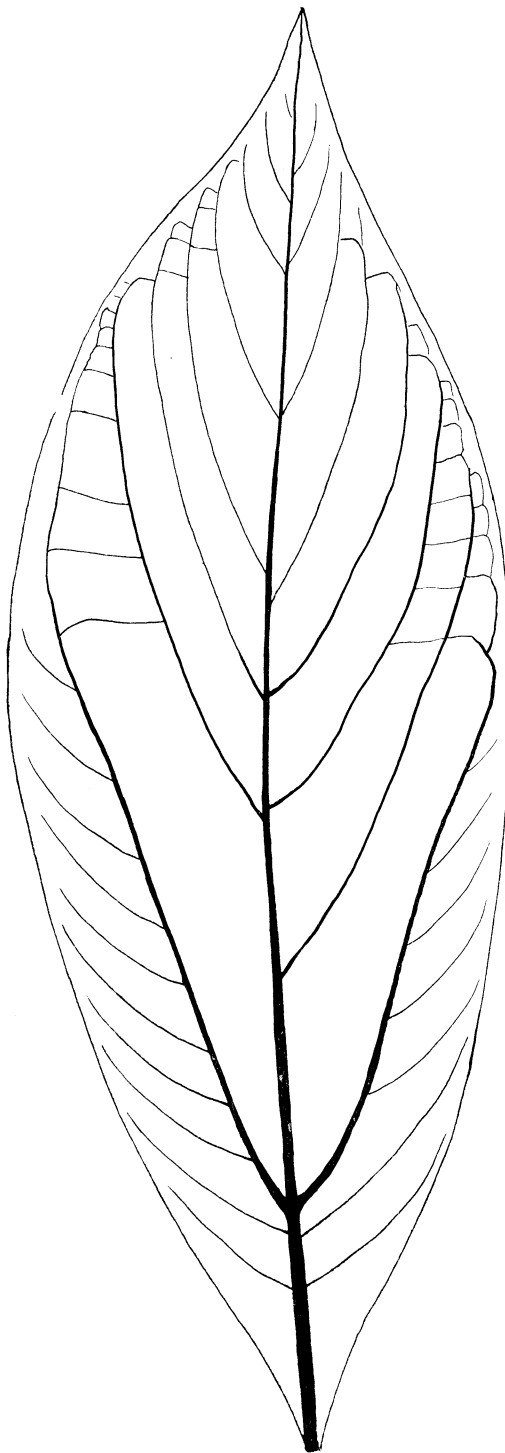
*Oreodaphne alabamensis* Berry sp. nov., Cottondale, Ala.



BRACHYPHYLLUM



ZIZYI HUS, RHUS, and STERCULIA



OREODAPHNE